ORIGINAL ARTICLE

How protective is breast feeding against diarrhoeal disease in infants in 1990s England? A case-control study

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Aims: To assess the effect of several measures of infant feeding on diarrhoeal disease, and whether these effects vary according to markers of social deprivation.
Methods: Case-control study of diarrhoeal disease cases presenting to 34 general practices in England. Controls were stratified on age group, area deprivation index for the practice, and whether or not the practice was in London. Data were available on 304 infants (167 cases and 137 controls).
Results: After adjustment for confounders, breast feeding was associated with significantly less diarrhoeal disease. Associations were striking even in infants aged ⩾ 6 months. They did not vary by social class, but were greater in those living in rented council accommodation and in more crowded households. The effect of receiving no breast milk was stronger in more deprived areas than in less deprived areas. The effect of not receiving exclusive breast milk was stronger in more deprived areas than in less deprived areas. In formula fed infants, there was significantly more diarrhoeal disease in those not sterilising bottles/teats with steam or chemicals. The protective effect of breast feeding did not persist beyond two months after breast feeding had stopped.
Conclusions: Breast feeding protects against diarrhoeal disease in infants in England although the degree of protection may vary across infants and wear off after breast feeding cessation. Education about the benefits of breast feeding and the risks of inadequate sterilisation should be targeted at carers in deprived areas or households.

The World Health Organisation[1] and UK government recommend exclusive breast feeding for the first six months of life. A recent UK survey[2] found that only 21% of infants were still breast fed at 6 months, and many of these were not exclusively breast fed. Seventy five per cent of women were aware of the health benefits of breast feeding in building immunity or fighting infectious diseases. Although high, this proportion indicates that 25% of UK mothers are unaware of the health benefits of breast feeding. Good quality, accessible information on which parents can make an informed choice about infant feeding is scarce.[3]

There is consistent evidence of a protective effect of exclusive breast feeding against diarrhoeal disease in the first 4–6 months of life.[4] Likely causes are the immune properties of breast milk and less exposure to pathogens in contaminated milk, food, bottles, or teats.[5] Contamination and inadequate sterilisation pose less of a problem in developed than developing countries, and this explains the greater protection of breast feeding in developing countries where poverty, poor hygiene, and infectious diseases are common.

Few studies have assessed whether the effect of breast feeding varies within a setting[6–8] or examined the role of inadequate sterilisation.[9] The present study aimed to measure the effect of breast feeding on diarrhoeal disease in 1990s England, to determine whether this effect varied by social deprivation, and to assess whether inadequate sterilisation is a risk factor.

METHODS

The present study formed part of a diarrhoeal disease study conducted in 70 general practices in England.[10 11] The practices were volunteers from the UK Medical Research Council's general practice research framework, and were nationally representative with respect to geographical location, urban and rural characteristics, and Jarman social deprivation index. Jarman scores were calculated for the ward in which the practice was based; higher values indicate more deprivation.[12] Thirty four practices participated in the GP case-control study. A diarrhoeal disease case was defined as someone who presented to the GP with loose stools or significant vomiting lasting less than two weeks, in the absence of a known non-infectious cause and preceded by a symptom-free period of three weeks. In the community cohort component of the main diarrhoeal disease study, the incidence rate for this definition of diarrhoeal disease was 3.5 and 3.2 per 100 person-years in infant boys and girls respectively. Age and sex matched controls, who had been free of loose stools or significant vomiting for three weeks, were selected from the practice's register. Cases and controls, or their guardians, were asked to complete a postal risk factor questionnaire, which included variables on infant feeding, social factors, accommodation, travel, and contact with persons with diarrhoeal disease. Ethical approval was obtained from the Royal College of General Practitioners, participating research bodies, and all local research ethics committees.

All cases and controls from the GP case-control study were eligible for inclusion in the present study if they were aged 1 year or less and had data available on infant feeding. Eligible cases and controls were stratified according to age group (0–3 months, 3–5.9 months, 6–8.9 months, ⩾9 months), Jarman score for the practice (<−5, −5 to 10, >10) and location of the practice (London, not London). These strata formed the matched sets for conditional logistic regression. The question on current milk feeding was ''How is your baby currently being fed milk: breast feed only, mixed breast/bottle feed, bottle feed only or other''. Infant feeding was defined as

Table 1 Unadjusted matched odds ratios for diarrhoeal disease and selected risk factors in all infants

	Cases (%)	Controls (%)	OR (95% CI)
Sex			
Male	105 (58%)	74 (52%)	1
Female	77 (42%)	68 (48%)	0.76 (0.48 to 1.19) p=0.23
Social class*			
I–III	131 (75%)	122 (86%)	1
IV–V/other	44 (25%)	20 (14%)	2.14 (1.19 to 3.85) p=0.011
Accommodation			
Own/mortgage	116 (65%)	109 (77%)	1
Rent—private	15 (8%)	12 (8%)	1.33 (0.59 to 3.01)
Rent—council	47 (26%)	21 (15%)	2.46 (1.31 to 4.59) p=0.014
Travel in past 10 days			
No	154 (86%)	121 (87%)	1
Holiday	6 (3%)	9 (6%)	0.47 (0.16 to 1.37)
Other	20 (11%)	9 (6%)	1.67 (0.74 to 3.80) p=0.15
Regular use of food mixer			
No	62 (34%)	28 (20%)	1
Yes	119 (66%)	114 (80%)	0.44 (0.25 to 0.76) p=0.003
Attends crèche/nursery			
No	162 (89%)	127 (89%)	1
Yes	20 (11%)	16 (11%)	0.99 (0.49 to 2.00) p=0.98
Crowding†			
<1	102 (71%)	82 (68%)	1
⩾1	41 (29%)	39 (32%)	0.94 (0.55 to 1.59) p=0.81
Contact with person with diarrhoea/vomiting in household			
No	148 (81%)	132 (92%)	1
Yes	32 (19%)	11 (8%)	2.62 (1.27 to 5.39) p=0.006
Contact with person with diarrhoea/vomiting outside household			
No	97 (54%)	112 (78%)	1
Yes	29 (16%)	11 (8%)	3.02 (1.43 to 6.39)
Not sure	54 (30%)	20 (14%)	3.30 (1.79 to 6.10) p<0.001
Current feeding			
EBM	11 (7%)	23 (17%)	1
Mixed	11 (7%)	15 (11%)	1.63 (0.55 to 4.85)
Formula	145 (87%)	99 (72%)	3.28 (1.48 to 7.23) p=0.004
Duration of breast feeding (months)			
Currently breast fed	22 (13%)	38 (28%)	1
⩾6 months, currently formula fed	16 (10%)	8 (6%)	3.97 (1.38 to 11.44)
3–5 months, currently formula fed	25 (15%)	28 (21%)	1.71 (0.78 to 3.75)
⩽2 months, currently formula fed	38 (23%)	32 (24%)	2.14 (1.03 to 4.47)
Never breast fed	63 (38%)	28 (21%)	3.87 (1.90 to 7.87) p=0.002, p=0.28‡
Months since breast feeding cessation			
Currently breast fed	22 (13%)	38 (28%)	1
⩽2 months	17 (10%)	18 (13%)	1.68 (0.71 to 3.93)
3–5 months	30 (18%)	21 (16%)	2.24 (1.02 to 4.92)
⩾6 months	32 (20%)	29 (22%)	2.57 (1.11 to 5.95)
Never breast fed	63 (38%)	28 (21%)	3.92 (1.92 to 7.99) p=0.004, p=0.70‡
Sterilisation of bottles§			
Chemical	78 (47%)	51 (44%)	1
Boiling water	14 (8%)	3 (3%)	3.81 (1.01 to 14.45)
Steam	60 (36%)	54 (47%)	0.73 (0.44 to 1.22)
Other/combination	15 (9%)	7 (6%)	1.42 (0.54 to 3.70) p=0.035

*Refers to main wage earner.
†Crowding = (no. persons in house excluding the infant)/no. rooms.
‡Excluding currently breast fed and never breast fed infants.
§In formula/mixed fed infants.
EBM, exclusive breast milk.

current milk feeding (exclusive breast milk, mixed feeding, or formula), whether the infant was weaned onto solids, and, for formula fed infants, whether they were ever breast fed and for how long. Thus we examined whether the effect of breast feeding persisted beyond the period of breast feeding and whether duration was important. Here, exclusive breast milk means that the only milk the infant received was breast milk, although many had been weaned onto solids.

Conditional logistic regression was employed to estimate adjusted odds ratios for infant feeding and method of sterilisation on diarrhoeal disease, and to assess whether the effect of breast feeding persisted after breast feeding had

ceased. Potential confounding factors associated with diarrhoeal disease ($p < 0.10$) were included in a multivariate model where infant feeding was the main exposure. The likelihood ratio interaction test was used to determine whether the effect of infant feeding varied according to social class (I–IIInm versus IIIm–V/other), crowding (<0.7 versus ⩾0.7 total persons in house/total rooms), accommodation type (rented council versus not), and Jarman (<1.5 versus ⩾1.5, where 1.5 was the median value). Population attributable fractions (PAFs) for diarrhoeal disease associated with infant feeding variables were estimated as (proportion of cases exposed)×(OR−1)/OR.[13] Survival analysis was used to estimate the prevalence of breast feeding at age 6 months while allowing for censoring, due to some infants being aged under 6 months. All analysis was conducted in Stata version 8.

RESULTS

The questionnaire was completed for 190 cases (60% of those sought) and 161 controls (90% of those sought). Twenty three cases (12%) and 24 controls (15%) were excluded for the following reasons: they had no data on infant feeding (5 cases, 18 controls); infant feeding was coded as ''other'' (15 cases, 6 controls all aged ⩾ 6 months); or they had no matched set (3 cases). The analysis was based on 167 cases and 137 controls (56 cases and 43 controls aged under 6 months; 111 cases and 94 controls aged over 6 months).

Among the 137 controls, 48% were female, 7% were aged under 3 months, 24% were aged 3–5.9 months, 34% were aged 6–8.9 months, and 34% were aged ⩾9 months. Controls were more likely to have ever breast fed (79%, 95% CI 71–86%) than infants in England and Wales in the Infant Feeding Surveys from 1995 (68%) and 2000 (71%), or be breast feeding at 6 months (27%, 95% CI 20–35%) than in the surveys from 1995 (22%) and 2000 (22%).[2] Among the controls, the proportion ever breast fed increased with social class of the main wage earner in the household from 57% in social class V to 88% in social class I.

In the unadjusted analysis, diarrhoeal disease was significantly associated with lower social class, living in rented council accommodation, not having access to a food mixer, having contact with a person with diarrhoea/vomiting within or outside the household, formula feeding, and, in infants not being breast fed, not using chemicals/steam to sterilise bottles (table 1). Months since breast feeding cessation and duration of breast feeding were both significantly associated with diarrhoeal disease, but much of these effects were due to the inclusion of the currently breast fed and never breast fed infants; neither was statistically significant when these infants were omitted. All except two infants aged ⩾6 months and 77% of infants <6 months had been weaned onto solids. For infants who had been weaned, information was not collected on the types of food they were weaned onto, but data were available on consumption of foods in the 10 days prior to symptoms in cases (interview in controls), but none were significantly associated with diarrhoeal disease (data not shown).

Effect of infant feeding and variation in effect

Formula milk was associated with nearly a fourfold increase in diarrhoeal disease compared with exclusive breast milk in infants aged under and over 6 months (table 2). The number of infants receiving mixed feeding was too small (table 1) to estimate precisely its effect on diarrhoeal disease, and for further analysis they were combined either with exclusive breast milk or with formula. Receiving no breast milk and not receiving exclusive breast milk were both significantly associated with an increase in diarrhoeal disease (adjusted OR = 2.74 and 3.62 respectively).

There was no statistically significant interaction between infant feeding and either social class or type of accommodation (table 3). The effect of not receiving any breast milk was stronger ($p_i = 0.064$ for interaction) in more crowded households (adjusted OR = 10.28) than in less crowded households (adjusted OR = 1.99). Moreover, the effect of not receiving any breast milk was stronger ($p_i = 0.105$ for interaction) in those infants whose GP was in a more deprived area (adjusted OR = 5.00) than in a less deprived area (adjusted OR = 1.56). Similarly, the effect of not receiving exclusive breast milk was stronger ($p_i = 0.004$ for interaction) in those infants whose GP was in a more deprived area (for Jarman ⩾1.5, adjusted OR = 17.66) than in a less deprived area (for Jarman <1.5, adjusted OR = 0.97). The data stratified by both social class and Jarman showed that in more deprived areas, there was a strong effect of infant feeding in the lower and higher social classes, whereas in the more affluent areas, there was a much smaller effect of infant feeding, especially in the higher social classes.

Table 2 Adjusted matched odds ratios for diarrhoeal disease and current infant feeding

	Age <6 months OR† (95% CI)	Age ⩾6 months* OR‡ (95% CI)	All infants OR§ (95% CI)
Current feeding			
EBM	1	1	1
Mixed	2.97 (0.51 to 17.33)	1.55 (0.26 to 9.36)	2.31 (0.66 to 8.14)
Formula	3.77 (0.95 to 15.02) p=0.14	4.49 (1.28 to 15.68) p=0.021	3.88 (1.55 to 9.72) p=0.008
Current feeding			
Any breast milk	1	1	1
No breast milk	2.21 (0.81 to 6.01) p=0.122	3.74 (1.39 to 10.03) p=0.009	2.74 (1.35 to 5.57) p=0.005
Current feeding			
EBM	1	1	1
Not EBM	3.64 (0.92 to 14.34) p=0.065	4.08 (1.17 to 14.17) p=0.027	3.62 (1.45 to 9.03) p=0.006

*Two infants who had not been weaned onto solids were excluded from models based on infants aged ⩾6 months.
†In infants aged <6 months, OR adjusted for age (as a continuous variable), weaning, social class, and contact with person in household.
‡In infants aged ⩾6 months, OR adjusted for age (as a continuous variable), sex, travel, mixer, contact with person with diarrhoea/vomiting in household and outside household.
§In models based on all infants, OR adjusted for age (as a continuous variable), sex, weaning, social class, travel, mixer, contact with person in household and outside household.
EBM, exclusive breast milk.

Table 3 Stratified matched odds ratios for diarrhoeal disease and current breast feeding in all infants

	Any breast milk		EBM	
	OR† (95% CI)	p value	OR† (95% CI)	p value
Overall	2.74 (1.35 to 5.57)	0.005	3.62 (1.45 to 9.03)	0.006
Social class				
I–IIInm	2.47 (1.07 to 5.69)	0.034	2.70 (0.90 to 8.15)	0.078
IIIm–V/other	3.47 (0.99 to 12.15)	0.052	5.29 (1.23 to 22.71)	0.025
	$p_i = 0.65$		$p_i = 0.45$	
Accommodation				
Not rent—council	2.33 (1.10 to 4.95)	0.028	2.79 (1.09 to 7.16)	0.032
Rent—council	6.39 (0.81 to 50.21)	0.078	− (infinity)	
	$p_i = 0.36$			
Crowding*				
<1 (less crowded)	1.99 (0.84 to 4.74)	0.120	2.98 (0.92 to 9.65)	0.068
⩾1 (more crowded)	10.28 (1.88 to 56.32)	0.007	6.98 (0.75 to 65.12)	0.088
	$p_i = 0.064$		$p_i = 0.49$	
Jarman				
<1.5 (more affluent)	1.56 (0.58 to 4.15)	0.37	0.97 (0.28 to 3.40)	0.96
⩾1.5 (more deprived)	5.00 (1.76 to 14.21)	0.003	17.66 (3.34 to 93.44)	0.001
	$p_i = 0.105$		$p_i = 0.004$	
Social class and Jarman				
I–IIInm, <1.5	1.05 (0.32 to 3.46)	0.94	0.39 (0.08 to 1.95)	0.25
IIIm–V/other, <1.5	1.96 (0.34 to 11.13)	0.45	2.62 (0.33 to 21.04)	0.36
I–IIInm, ⩾1.5	6.10 (1.79 to 20.77)	0.004	21.51 (3.01 to 153.7)	0.002
IIIm–V/other, ⩾1.5	6.37 (0.97 to 41.94)	0.054	15.35 (1.42 to 166.4)	0.025
	$p_i = 0.18$		$p_i = 0.009$	

*Crowding = (no. persons in house excluding the infant)/no. rooms.
†OR adjusted for age (as a continuous variable), sex, weaning, social class, travel, mixer, contact with person in household and outside household.
EBM, exclusive breast milk.
p_i, p value from interaction test.

Effect of sterilisation of bottles/teats on infant feeding

Sterilisation of bottles and teats was significantly associated with diarrhoeal disease, the highest risk being among the small number who did not use chemicals or steam to sterilise (table 4). This effect was particularly strong in infants aged <6 months (adjusted OR = 9.13, 95% CI 1.17 to 71.39, p = 0.012) although the effect in infants aged ⩾6 months was of borderline statistical significance (adjusted OR = 2.29, 95% CI 0.85 to 6.14, p = 0.09). Among formula fed infants, the PAF for diarrhoeal disease associated with not sterilising with chemicals/steam was 12%. In all infants, the PAF for diarrhoeal disease associated with formula compared with exclusive breast milk was 53% when sterilising with chemicals/steam and 13% when not sterilising with chemicals/steam.

Persistence and duration of breast feeding effect

In order to assess whether the effect of breast feeding on diarrhoeal disease persisted beyond the period of breast feeding, we examined the effect of past breast feeding in infants currently being formula fed. There was no strong association between ever having been breast fed and diarrhoeal disease (table 5). When months of breast feeding was analysed as an ordinal variable, there was no evidence of a dose-response effect of breast feeding duration. Further, in infants currently formula fed, having been breast fed for at least six months was not associated with less diarrhoeal disease than having never been breast fed (for 6+ months versus never breast fed, adjusted OR = 1.14, 95% CI 0.38 to 3.40, p = 0.81). However, the odds of diarrhoeal disease increased with the time since breast feeding cessation ($p_T = 0.002$ for linear trend in all infants). There was little evidence of the protection of breast feeding persisting beyond two months following breast feeding cessation, even after allowing for age and other potential confounders.

DISCUSSION

Breast feeding was associated with significantly less diarrhoeal disease, even in infants aged ⩾6 months. These effects did not vary by social class, but were stronger in more deprived areas and in more crowded households. Formula fed infants experienced more diarrhoea if their bottles/teats were not sterilised with steam or chemicals. There was no evidence of a dose-response effect for breast feeding duration but there

Table 4 Adjusted matched odds ratios and population attributable fractions for infant feeding and sterilisation in all infants

	Cases	Controls	OR† (95% CI)	PAF
Sterilisation of bottles*				
Chemical/steam	138 (83%)	105 (91%)	1	
Boil/other	29 (17%)	10 (9%)	3.42 (1.43 to 8.17)	12%
			p = 0.006	
Infant feeding and sterilisation				
EBM	11 (7%)	23 (17%)	1	
Mixed and chemicals/steam	7 (4%)	12 (9%)	2.36 (0.55 to 10.10)	2%
Mixed and boil/other	4 (2%)	3 (2%)	3.45 (0.55 to 21.55)	1%
Formula and chemicals/steam	121 (73%)	90 (67%)	3.57 (1.39 to 9.15)	53%
Formula and boil/other	23 (14%)	7 (5%)	14.04 (3.78 to 52.09)	13%

*In those not currently breast feeding.
†OR adjusted for age (as a continuous variable), sex, weaning, social class, travel, mixer, contact with person in household and outside household.
EBM, exclusive breast milk.
PAF, population attributable fraction.

Table 5 Adjusted matched odds ratios for diarrhoeal disease and past infant feeding factors

	Age <6 months OR‡ (95% CI)	Age ≥6 months OR§ (95% CI)	All infants OR¶ (95% CI)
Ever breast fed*			
Yes	1	1	1
No	1.55 (0.44 to 5.42) p=0.49	1.39 (0.64 to 3.04) p=0.41	1.47 (0.76 to 2.83) p=0.25
Duration of breast feeding (months)			
Currently breast fed	1	1	1
≥6 months, currently formula	NA	5.36 (1.45 to 19.82)	4.49 (1.42 to 14.23)
3–5 months, currently formula	0.79 (0.12 to 5.34)	2.92 (0.97 to 8.78)	2.02 (0.85 to 4.85)
≤2 months, currently formula	2.57 (0.79 to 8.39)	2.11 (0.64 to 6.91)	1.93 (0.83 to 4.49)
Never breast fed	3.48 (0.96 to 12.58) p=0.14, p=0.079†	4.83 (1.57 to 14.92) p=0.34, p=0.13†	3.93 (1.71 to 9.05) p=0.010, p=0.53†
Months since stopped breast feeding			
Currently breast fed	1	1	1
≤2 months	1.13 (0.30 to 4.24)	3.86 (1.05 to 14.18)	1.88 (0.74 to 4.80)
3–5 months	3.92 (0.92 to 16.63)	2.75 (0.86 to 8.76)	2.42 (0.99 to 5.91)
≥6 months	NA	3.38 (1.10 to 10.40)	2.50 (0.96 to 6.51)
Never breast fed	3.24 (0.89 to 11.76) p=0.0.093, p=0.042†	4.97 (1.63 to 15.18) p=0.062, p=0.77†	3.90 (1.69 to 8.98) p=0.026, p=0.57†

*In formula fed infants.
†Excluding currently breast fed and never breast fed infants.
‡In infants aged <6 months, OR adjusted for age (as a continuous variable), weaning, social class, and contact with person in household.
§In infants aged ≥6 months, OR adjusted for age (as a continuous variable), sex, travel, mixer, contact with person in household and outside household.
¶In models based on all infants, OR adjusted for age (as a continuous variable), sex, weaning, social class, travel, mixer, contact with person in household and outside household.
NA, not applicable.

was for time since breast feeding cessation, with the protective effect of breast feeding not persisting long after breast feeding had stopped. In order to assess the potential for bias, we explored whether breast feeding status changed following the onset of diarrhoea. Of the 150 infants (81 cases, 69 controls) who were currently on formula only, but who had previously been breast fed, there were only 4 (2 cases, 2 controls) who were breast fed in the previous month. Hence, the potential for cases to have changed from breast to formula due to diarrhoea is minimal. Recall bias for months since breast feeding cessation cannot be ruled out, neither can response bias, particularly if breast feeding differed substantially between responders and non-responders.

Our observed protective effect of breast feeding is consistent with findings from studies conducted in the 1980s and 1990s in Scotland,[14] England,[15] the USA,[8 16] and Canada,[17] although a study in a middle-class Danish population found no effect.[18] A breast feeding intervention trial in Belarus resulted in an increase in breast feeding and a reduction in diarrhoea,[19] although the generalisability of these findings to other settings may be limited.

While many studies have observed that breast feeding protects against diarrhoea, few have explored the variability of this effect.[6–8] Our study is the first to show that breast feeding may confer greater protection against diarrhoea in deprived rather than affluent areas or households within a developed country. An interaction with crowding and area, but not with social class, is plausible: person to person spread is a likely mode of transmission for viruses, a common cause of diarrhoea in these infants;[11] and contact with a case was a risk factor for diarrhoea. Hence the interaction with crowding, a marker of transmission risk within the household, but not with social class. The Jarman index measures area deprivation, which may also reflect local transmission.

Studies in developing countries have found variability in the effect of breast feeding. A study in Malaysia[6] found that formula feeding had a much stronger effect on mortality in infants living in households without piped water or a toilet than in households with toilets. In a diarrhoeal disease study in the Philippines, there was a stronger protective effect of breast feeding in the more crowded urban areas than in rural areas.[7] Maternal education has been shown to interact with the effect of breast feeding on mortality in less developed countries,[20] but this variable was not collected in our study. Household income has been shown to interact with child growth in Brazil.[21] A US study of diarrhoeal disease found no interaction between breast feeding and household income.[8] Household income, like social class, may not be a good marker of transmission risk.

There is good microbiological and immunological evidence for the different mechanisms by which breast feeding confers protection against diarrhoea,[5] but few epidemiological studies have measured their relative importance. In our study, the estimated proportion of diarrhoea cases that would be prevented if formula fed infants had been exclusively breast fed was 53% for chemical/steam sterilisation and 13% for other sterilisation methods. These other sterilisation methods may be associated with inadequate sterilisation; bottles require boiling in water for 10 minutes in order to be sterilised and this may not always happen in practice. In this setting, inadequate sterilisation probably causes less infant diarrhoeal disease than the formula milk itself lacking the immunological and nutritional properties of breast milk. Among the formula fed infants in a study in Iraq, sterilisation of bottles and teats was not associated with diarrhoeal disease, although inadequate sterilisation among less educated mothers may have concealed a true effect.[9] The Iraq study, like ours, found little evidence of the protection of breast feeding persisting beyond two months after breast feeding has stopped which, if true, will influence the optimal duration of breast feeding for preventing diarrhoea. Our results suggest that the cumulative effect of breast feeding, as measured using duration, is less important for diarrhoeal disease than the time since breast feeding cessation. Importantly, we found that in infants currently formula fed, having been breast fed for at least six months was not associated with less diarrhoeal disease than having never been breast fed. Our sample size was not large enough to allow simultaneous modelling of the effects of duration and time since cessation. Further studies should try to disentangle these effects, while also distinguishing between exclusive and partial breast feeding.

Good quality, evidence based information on the risks and benefits associated with infant feeding methods should

What is already known on this topic

- Exclusive breast feeding protects against diarrhoeal disease
- Little is known about the variability of this effect according to social deprivation, or whether inadequate sterilisation of bottles/teats plays an important role

What this study adds

- Breast feeding may be more protective against diarrhoeal disease in infants in more deprived areas than in less deprived areas, and in more crowded households than in less crowded households
- Inadequate sterilisation is a risk factor for diarrhoeal disease among formula fed infants in this setting

inform government policy and enable parents to make an informed choice. Our new findings confirm that breast feeding protects against diarrhoeal disease in infants in England, but suggest that the degree of protection may vary across infants and wear off after cessation of breast feeding. Education about the benefits of breast feeding and the risks of inadequate sterilisation should be targeted at carers in deprived areas and crowded households. Further studies should examine variation in and persistence of the effect of breast feeding, and the role of inadequate sterilisation.

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